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BIOMEDICAL MONITORING AND COMPUTATIONS
SYSTEM Final Report (Space Craft, Inc.)
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SPACE CRAFT, INC.
HOUSTON, TEXAS



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**USERS MANUAL
FOR
SESL-EMU
BIOMEDICAL MONITORING
AND
COMPUTATIONS SYSTEM**

June-1969

**prepared by
SPACE CRAFT INC.
HOUSTON, TEXAS**

1.0 SCOPE

1.1 PURPOSE

This document provides the user of the SESL Energy Computation System (SESL - EMU - MR) with the procedure necessary to operate the system and detailed information concerning the actual computations which are being performed.

1.2 CONTENT

This document contains the steps necessary to load the system tape, the options which are available to the user, the system description, and the computations being performed on a real-time basis.

2.0 SYSTEM DESCRIPTION

The SESL - EMU - MR is a real-time data acquisition and real-time computation system. Once the start test command has been received, the system inputs 32 channels of digitized analog parameters every 20 milliseconds. One seconds worth of data is accumulated prior to performing any calculations. Once every second the local and test times are updated on the display. Once every fifteen seconds the two computed heart rates, the energy values, and total energies are updated on the display screen. Once each minute, the values for minute heart rate energy, oxygen energy, and LCG energy are output on the teletype to produce a permanent record for the test.

The above comprises the basic sequence of events. At any time the program responds to a keyboard interrupt. The impact that this causes to the operation of the system

is described in Section 3.0.

3.0

SYSTEM LOAD PROCEDURE

1. Load the bootstrap loader (see Section 3.2 of Varian 620i Programing Reference Manual) and Binary Load/Dump Program (BLD).
2. Using BLD the AID II program is loaded (See section 3.3 Programing Reference Manual).
3. Using BLD the SESL - EMU - MR program is loaded.
4. To set the program into execution it is necessary to clear all the registers, enter 15000 (OCTAL) into P, depress System Reset and Run.

3.1

SESL - EMU - MR NOMINAL TEST SEQUENCES

1. Perform steps 1-4 as described in Section 2.0.
2. Enter CD command. Modify first line of display and computational constants as described in Section 3.1.
3. Execute Start Test (ST) command.
4. Execute RI command to start Heart Rate computations.
5. Execute PI command to start energy computations.
6. Execute OI command to start Oxygen energy computations.
7. Execute IT command as required.

4.0

USER OPTIONS

Some 19 legal operation entries are recognized by the SESL - EMU - MR Program. These commands were established to provide maximum flexibility and ease of use of this system. It is the purpose of this section to list all of theses commands and detail what action is taken by the program when one of these commands is recognized. Some of these commands must be used with some caution. These

commands are indicated with an asterisk and the user is urged to read Section 5.0 before entering one of these commands.

To enter a command the following sequence must be strictly adhered to. First it is necessary to verify that the blue light on the keyboard is illuminated. If this indicator is not ON this means that the keyboard is not enabled to accept input. This situation arises whenever the computer is reading/writing into the display memory. Under normal conditions the light blinks as accessing the display memory is done on a cyclic basis. Should the light remain OFF for more than a second it is necessary to verify that Display Controller is operating in the correct configuration. If the CC - 30 unit is in the correct configuration, it is recommended that the operator reload the SESL -EMU - MR tape and restart the test. When the blue light is verified to be ON the command sequence is initiated by depressing the INT button which halts update of the display and resets the cursor to the upper left hand corner of the screen. The operator then enters the command (starting from the reset cursor position) and depresses the INT button. The program acknowledges valid commands by blanking the command from the screen. Should the operator enter a command not contained in this list the program acknowledges the illegal entry by sending back two question marks. No other action occurs.

Occasionally contact bounce causes the above sequence to be altered. Should one of the commands not be accepted, or an expected response does not occur, the user is urged to try a couple of fixes. Repeat the sequence. If this does not solve the problem, do not enter the first interrupt.

In all cases, one of the above two methods have been succesful in getting the desired command accepted.

COMMAND**MEANING****TE**

Teletype Enable. All previous messages are cleared from the various teletype buffers and the teletype driver is reinitialized.

TD

Teletype Disable. The teletype driver is disabled. Any teletype output currently in progress is halted and no further output will occur until the system is reloaded or TE command is received.

ET

End Test. The program goes into an idle mode. All computations are stopped, the clock interrupts are disabled and the "READY" message is put onto the screen.

***RI**

Heart Rate Computation Initiate. The EKG program is started. Once each 15 seconds the minute heart rate is displayed on the screen. After the first minute, the average heart rate is displayed.

RT

Heart Rate Computation Terminate. The EKG program is disabled. The minute and average heart rates currently being displayed are left on the screen, no further update of these two values will occur.

***PI**

Energy Computation Initiate. The energy computation program(s) are started provided this command is received in the proper sequence. Otherwise, two question marks are output to display screen, and no further action is taken.

PT

Energy Computation Terminate. The energy computation program is disabled. Energy values being displayed at the time the PT command is received are not updated.

***OI**

Oxygen Computation Initiate. The program which performs the O_2 energy computations is enabled. Reference Section 5.2.

OT

Oxygen Computation Terminate. The O_2 energy computation program is disabled. O_2 energy values being displayed at the time the OT command is recognized are left on the screen and not updated.

COMMAND**MEANING**


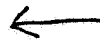


ST	Start Test. The real-time clocks are enabled, the data scan is started, the display is output with only the time being updated. The display is being driven at its maximum rate and it is necessary to hold the INT button down continuously in order to get program attention. If this command was preceded by an ET command the display as it existed at the time the ET command was received is restored, but only the time will be updated.
RS	Restart. The command simulates a system load. The display is initialized and zero is inserted for all quantities. The real-time clock interrupts are disabled thus the data scan is halted. The READY message is output to the screen. All computations are halted.
IT	Interval. The current minute energies are copied onto one of the seventeen lines on the display screen, corresponding to one to seventeen intervals, and also on the teletype. The number of intervals is modulo 18 with overlay of line 1 occurring each eighteenth interval. Verification, the wraparound has occurred, can be made by comparing the interval 1 to interval 17 times. After the interval energy has been hardcopied onto the teletype two extra blank lines are output indicating the start of a new interval.
*IN	Sweat Factor Command. Reference Section 5.3.
*IZ	Sweat Factor Command. Reference Section 5.3.
CD	Constant Display. The currently used constants for the heart rate computations and the LCG suit leak rate constant are displayed for operator inspection. This display remains on the screen until a CU command is received.
*CU	Constant Update. After requesting the constants to be displayed the operator may enter a new test subject name and chamber designator. The computational constants currently in use may be changed at the users option. Whether changed or not the constants are recomputed everytime a CU command is recognized. The procedure for making the changes is described in Section 3.1.

COMMAND**MEANING****M1****Mads 1.** This command selects mads-1 for data input.**M2****Mads 2.** This command selects mads-2 for date input.**BB****Blanks.** Two blanks are recognized as legal characters. No action results upon recognition of blanks.

4.1 PROCEDURE FOR CHANGING COMPUTATION CONSTANTS.

4.1.1 Enter CD command to get the constants display.

4.1.2 To change the display title position the cursor beneath the chamber number and type in the new chamber number test subject name.

NOTE: This is best accomplished using the cursor control button (   ),

as depressing the space bar insert a blank at the current cursor position, per depression. Should a blank be inserted by mistake it is necessary to restore the blanked character.

4.1.3 To change the constants the cursor (see note in 2.0).

Control buttons should be used. The cursor is placed beneath the first character to the right of the asterisk.

It is necessary to input all characters between each pair of asterisks. For example, if a suit leak rate of 6 is desired it is necessary to input 006. No software protection is provided other than a hardcopy of the value of the constants in use prior to the update.

4.1.4 It is urged that the user have a clear understanding of Section 5.1 before executing a CU command.

5.0

METABOLIC RATE COMPUTATIONS

5.1 METABOLIC RATE COMPUTATIONS FOR HEART RATE

5.1.1 Inputs Required:

Input Sources	Description	Symbol	Data Format
A/D Channel #19 via BIC 1, ADC Device #54 MADS (1) or (2)	50 S.P.S. pulse rate of astronaut from ECG preprocessor	HR	XXXX counts
AID Program via TTY (see common map for memory location)	Slope of astronauts pulse versus metabolic rate (presently set to ± 21.45 in floating point)	AS	XX.XX
AID (see common map for memory location)	Y-Axis intercept of astronauts pulse versus metabolic rate (presently set to -1000. in floating point)	AB	XXXXX
Display Keyboard	Start test by initializ- ing program buffers, peripherals, etc.	ST	XX
Display Keyboard	End test-terminate program	ET	XX
Display Keyboard	Start computation for Heart Rate	RI	XX
Display Keyboard	Stop computations for Heart Rate	RT	XX
Display Keyboard	BTU/HR Program Start	PI	XX
Display Keyboard	Re-start whole system or test	RS	XX
Display Keyboard	BTU/hr Program Stop	PT	XX
Display Keyboard	Start/Stop Metabolic Rate Intervals (X_0 thru X_n on system B Display and teletype output	IT	XX

Input Sources	Description	Symbol	Data Format
AID	Detailed Test Procedure (alphanumeric constants entered prior to test) NOTE: Presently act to DT01 thru DT17	DTP	XXXX
Display Keyboard	Constants Displayed and connected automatically	CD	see AS & AB above
Display Keyboard	Constants updated and converted automatically for display as well as setting appropriate memory location	CU	see AS & AB above

5.1.2 Computations and Associated Outputs Required for Heart Rate

- 5.1.2.1 Obtain a 15 sec. count of pulses per computation sequence described on page 5 of SNR6.4.1.1-2960-171, Revision A WPIL #3 once the "RI" command is inputted from the display keyboard. Upon obtaining first 15 sec. heart rate after each "RI" command is given, apply the following blanking factors to eliminate any noise from the ECG Preprocessor for the next 15 sec. heart computation:

<u>Heart Rate (B/MIN)</u>	<u>Blanking Time</u>
Greater than or equal to 180	300 milliseconds
160 to 180	320 "
140 to 160	340 "
120 to 140	360 "
100 to 120	380 "
90 to 100	400 "
80 to 90	420 "
less than 80	440 "

- 5.1.2.2 Upon obtaining a 15 sec. count of pulses, multiply it by 4 to produce a 1 Minute Heart Rate and display it as follows:

$$\text{MIN HR} = \underline{\text{XXX}}$$

- 5.1.2.3 The average heart rate is the next computation to be made following the computations of the first four 1 minute heart rates and then every sliding 15 seconds thereafter.

For example:

1st 15 sec. Count	= 20 * 4 = 80	(1 Minute Heart Rate)
2nd " "	= 21 * 4 = 84	" " " "
3rd " "	= 25 * 4 = 100	" " " "
4th " "	= 22 * 4 + 88	" " " "

$$\sum_{i=1}^4 \text{Minute HR}_i = 352$$

$$\text{1st Average Heart} = \frac{352}{4} = 88.$$

Displayed as
AVG HR XXX

2nd thru Nth Average Heart computed every 15 secs. as follows:

2nd	= 84
3rd	= 100
4th	= 88
5th	25*4 = 100

NOTE: 1st 15 sec. removed from previous computation

$$\text{2nd Average Heart Rate} = \frac{372}{4} = 93$$

Thus, Average Heart Rate shall be updated every 15 secs. using this sliding technique provided the RT command is not inputted via the display console.

- 5.1.2.4 Once the "PI" command is initiated via the display console, the one (1) minute energy computations shall be started and X_0 Local Time displayed. This computation shall be made as follows:

$$1 \text{ Minute Energy (BTU/HR)} = AS(HR) + AB$$

where, AS = slope described under inputs required

AB = Y-axis intercept described under inputs required

HR = Average Heart computed after 1st minute and every fifteen seconds thereafter.

MIN \square XXXX

If 1 minute heart rate energy is less than 0, a zero (0) shall be displayed.

If 1 minute heart rate energy is greater than 4000, 9999 shall be displayed.

- 5.1.2.5 Once the 1 minute energy is computed, the average energy can be updated. (Display on CRT as: AVG XXX)
This computation shall be as follows:

$$\text{Average Energy} = \frac{\sum_{t=1}^n Q_t}{n}$$

where,

Q_t = 1 min energy calculation

n = total number of 1 minute energy computation

For example,

n	1 Minute Energy	Average Energy Displayed
1	1000	1000
2	2000	1500
3	1000	4000/3

- 5.1.2.6 Once the "IT" interrupt command is initiated via display keyboard, the average energy is displayed on CRT and teletype with associated local time and Detailed Test Procedure.

Example,

	HR	O ₂	LCG	DTP
X ₁ X ₁ :X ₁ X ₁ :X ₁ X ₁	INT <input checked="" type="checkbox"/>	XXXX	XXXX*	XXXX*H RES

* Described in O₂ and LCG metabolic rate computation documents

Everytime the "IT" command is given a new interval energy line shall be displayed on the CRT and teletype.

Note: The 17th interval shall then be inserted in place of the 1st interval line and the whole process continued for as many "IT" commands as inputted. After the command is given, average energy is reinitialized for the next interval.

- 5.1.2.7 The final energy computation made for heart rate shall be the total Energy which is computed and updated everytime a 1 minute Energy is computed and updated.
The computation for TOTAL ENERGY shall be as follows:

$$\text{Total Energy} = \sum \left(1 \text{ minute Energy} * \frac{1}{240} \right) \text{ for whole test.}$$

Total Energy for heart rate shall be displayed as follows:

TOT ☒ XXXX

5.2 METABOLIC RATE COMPUTATIONS FOR O₂ CONSUMED

5.2.1 Inputs required:

Input Sources	Description	Symbol	Data Format
A/d Channel #34 via BIC (1), ADC Device #54 MADS (1) or MADS (2)	PLSS Oxy. Bottle Pressure (1S.P.S.)	O ₂	XXXX
AID (see map of common for memory location)	Oxy. Resolution Factor in floating point (presently set to 1.085)	AMAX	XXXXXX (2 words used)
AID/Display Keyboard (see CD Command)	Suit leak rate	SLR	XXX
620i Buffered I/O Controller Device #60	Local Time (see page 9 of EB-S-68-4041-U)	LOCAL	See Figure 6 EB-S-68-4041
Display Keyboard	Start Test	ST	XX
Display Keyboard	End Test	ET	XX
Display Keyboard	Hold Initiate (Hold and stop O ₂ computations)	OT	XX
Display Keyboard	Hold Terminate (Begin O ₂ computations with previous comps.)	OI	XX
Display Keyboard	BTU/HR Program Start	PI	XX
Display Keyboard	BTU/HR Program Stop	PT	XX
Display Keyboard	Start/Stop Metabolic Rate Intervals (X ₀ thru X ₁₆ on System B display and teletype)	IT	XX
AID	Detailed Test Procedure (Alphanumeric constants entered prior to test)	DTP	XXXX
O ₂ subroutine constant	Toss out factor for \bar{P}_1	ITQS	XX
O ₂ subroutine constant	P _A for computation	PA	XX
Display Keyboard	Re-start whole system or test	RS	XX

5.2.2 Computations and Associated Outputs Required for O_2 consumed.

5.2.2.1 Once the PI followed by the QI command is entered via the keyboard, obtain the PCM counts for O_2 bottle pressure from Channel 3 via BIC (1), ADC Device #54. Also begin timer to keep track of each second of data.

5.2.2.2 Criteria for determining an Oxygen energy computation shall be as follows:

5.2.2.2.1 Average first 10 samples of O_2 to obtain \bar{P}_0 .

$$(e.g.) \bar{P}_0 = \frac{\sum_{i=1}^{10} O_{2i}}{10}$$

where O_{2i} = PMC O_2 counts

5.2.2.2.2 Screen the next 10 samples of O_2 to obtain \bar{P}_1 eliminating those samples from the computation that are greater than the toss out factor.

i.e., If \bar{P}_0 - Toss Out Factor - present O_2 count:

Less than or equal to zero, use in average Greater than zero, do not use in average.

5.2.2.2.3 In order to make \bar{P}_1 computations, a minimum of 2 valid samples must be obtained using the above condition within 10 secs. The computation for \bar{P}_1 is as follows:

$$\bar{P}_1 = \frac{\sum_{i=1}^N O_{2i}}{N}$$

where,

N = numbers of valid samples with the next 10 consecutive seconds.

5.2.2.2.4 Upon obtaining \bar{P}_0 and \bar{P}_1 , compute the difference between them and test to see if it is greater than or equal to P (Tolerance factor). If it is, make the O_2 computation. If it is not, disregard \bar{P}_1 and recompute \bar{P}_1 using next 10 consecutive seconds of data.

5.2.2.2.5 If the one minute (Delta) energy rate is greater than 4000 BTU/Hr, displayed for Delta O_2 Energy and not added to the average and total O_2 energy cells.

5.2.3 Calculate time duration T in minutes once the conditions are satisfied per paragraph 5.2.2.2.4.

$$\bar{P}_0 = 250 = 0.167 \text{ Minutes}$$

$$\bar{P}_1 = 246 = 0.334 \text{ Minutes}$$

$$\Delta T = 0.334 - 0.167 = 0.167 \text{ Minutes}$$

5.2.4 If the above criteria are met, compute the 1 Minute (Delta) Energy as follows:

$$1 \text{ Minute Delta Energy} = \frac{n * O_2 \text{ RES}}{T} * 447. - \text{SLR}$$

where, n = count change; SLR = suit leak rate constant XXX

$O_2 \text{ RES}$ = resolution computed by: $\text{AMAX} = O_2 \text{ RES} = \frac{\text{RES}}{253}$; $\text{PMAX} =$

input constant

T = minutes

253 = 8 bit PCM; 1023 = 12 bit PCM AMAX presently set to 1.085

The 1 minute energy for O_2 shall be displayed as follows on the CRT:

OXY
 ^ □ XXXX

5.2.5 The average energy shall be computed as follows:

$$\text{Average Energy} = \sum \text{minute Delta energies} * (60/\Delta t)$$

where, Δt = sum of Δt 's at this point in time for this interval.

Average O_2 Energy shall be displayed as XXXX.

5.2.6 Upon receiving the IT command, the average energy shall be displayed on CRT and the teletype with associated local time and Detailed Test Procedures.

Example,

Local Time			HR	OXY	LCG	DTP
X ₁ X ₁	: X ₁ X ₁	: X ₁ X ₁	INT 3 XXXX	XXXX	XXXX	REST

5.2.7 The Total Energy computation and display shall be made as follows:

$$\text{TOT} = (1 \text{ minute energies} * \frac{\Delta t}{60} = \text{XXXX})$$

Actual Display = XXXX

5.3 Metabolic Rate computations for Liquid Cooled Garment

5.3.1 Inputs Required:

<u>Input Sources</u>	<u>Description</u>	<u>Symbol</u>	<u>Data Format</u>
A/D Channel #5 via Bic #1 ADC Device #54 MADS (1)/(2)	Delta Temp. of LCG	IDTT	XXXX
A/D Channel #7	LCG Inlet Water Temp.	ITWI	XXXX
A/D Channel #29	Sublimator O2 Temp. at Outlet to the Suit	IDEW	XXXX
Display Keyboard	Start test by initializing	ST	XX
Display Keyboard	End test-terminate programs	ET	XX
Display Keyboard	RE-start whole system or test	RS	XX
Display Keyboard	BTU/Hour Program Start	PI	XX
Display Keyboard	BTU/Hour Program Stop	PT	XX
Display Keyboard	Start/Stop Metabolic Rate Intervals (X_0 thru X_n) on display and teletype	IT	XX
AID	Detailed test Procedure (alphanumeric constants entered prior to test) Note: Presently set to DT01 thru DT17	DTP	XXXX
AID (see common map for memory location)	Delta Temp. resolution factor (Deg F/count) Note: Presently set to 15/1023 in floating point.	TRES	XXXXXX (2 words)
AID (see map of common)	Resolution factor for Temp. of coolant at inlet to LCG. (Presently set to 90/1023 in floating pt.)	TDRS	XXXXXX (2 cells)
AID (see map of common)	Resolution Factor for sublimator O2 inlet Temp. (Presently set to 90/1023 in floating f+.)	TDRS	XXXXXX (2 cells)
AID	Slopes for LCG tables 1 thru 6 (see map of common for present settings)	A1 thru A6	XXXXXX (2 cells each)

<u>Input Sources</u>	<u>Description</u>	<u>Symbol</u>	<u>Data Format</u>
AID	Intercepts for LCG tables 1 thru 6 (see map of common for present settings)	IB1 thru IB6	XXXXXX (2 words each)
Display Keyboard	Sweat Factor IS = 0; IN = 1 (Initially set to 1)	IN or IS	1X
AID (see map of common)	Spacesuit radiant heat gains or loses (Presently set to -100)	ISUN	XXXXXX
AID (see common map)	Flow rate of coolant thru garment (Presently set to +240)	IFLG	XXXXXX
AID	Flow rate of gas thru suit (presently set to +48 or 4.8 cfm)	IFLS	XXXXXX

5.3.2 Computations and Associated Outputs Required for Liquid Cooled Garment

5.3.2.1 Calculate the heat picked up by the coolant flowing through the liquid cooled garment once the 12 bit counts from the A/D converter have been averaged for every 15 consecutive seconds of data. (i.e.,

$$\begin{aligned} \text{Average IDTT} &= \frac{\sum_{i=1}^{15} \text{IDTT}_i}{15} \\ \text{Average ITWI} &= \frac{\sum_{i=1}^{15} \text{ITWI}_i}{15} \\ \text{Average IDEW} &= \frac{\sum_{i=1}^{15} \text{IDEW}_i}{15} \end{aligned}$$

where,

IDTT_i = 1st thru 15th consecutive seconds of Delta Temp. of LCG.

ITWI_i = 1st thru 15th consecutive seconds of inlet water temp.

IDEW_i = 1st thru 15th consecutive seconds of subl. O2 at inlet to the suit.

Prior to using the above average in the LCG heat pick-up thru the suit the following conversions must be made:

$$\text{Delta temp. in Engr. Units} = \text{IDTT} * \text{TRES}$$

Now the heat picked up through the suit is computed as follows:

$$\text{IQLC} = \text{ITWI} * \text{IDTT}$$

where,

IQLC = heat picked up

- 5.3.2.2 At this point, if the Delta Temp. (IDTT) is greater than or equal to 10 the following total adjusted metabolic rate (ISLC).

$$\text{ISLC} = \text{IQLC} + 200 * \text{IFAC} + \text{ISUN}$$

- 5.3.2.3 If the delta temp. (IDTT) is less than 10, obtain the metabolic rate (IMRI) at the inlet coolant temp. of the LCG at comfort as follows:

$$\text{Inlet water temp. in Engr. Units (ITWI)} = \text{ITWI} * \text{ITRS}$$

- (a) If $\text{ITWI} - 63$ is less than or equal to zero, compute IMRI as follows:

$$\text{IMRI} = \text{A1} * \text{ITWI} + \text{IB1}$$

where,

A1 = slope associated with table labeled AQMETT (curve 1) presently set to -40.218.

IB1 = intercept associated with table AQMETT (curve 1) presently set to +3133.

- (b) If $\text{ITWI} - 63$ is greater than zero, compute IMRI as follows:

$$\text{IMRI} = \text{A6} * \text{ITWI} + \text{IB6}$$

where,

A6 = slope (curve 1) = presently set to -31.48

IB6 = intercept (see curve 1) = presently set to +3133.

- 5.3.2.4 Obtain the gas temp. out of the suit (ITGO) based on IMRI from Curve 2.

$$\text{ITGO} = \text{A2} * \text{IMRI} + \text{IB2}$$

where,

A2 = slope (see curve 2) = presently set to -0.002667

IB2 = intercept (see curve 2) = presently set to +89.

5.3.2.5 Convert IDEW to engineering units:

$$\text{IDEW} = \text{IDEW} * \text{TDRS}$$

and then calculate the inlet gas temp. to the suit (ITGI) from the subl. O₂ outlet temp. and the heat load between the sublimator outlet and the suit inlet.

e.g.,

$$\text{ITGI} = \text{IDEW} + 5.0 / (0.3 * \text{IFLS})$$

where,

5.0 = heat load constant

$$0.3 = \frac{(3.85) (144) (60) (.22)}{(48.24) (510)}$$

where 3.85 is the O₂ pressure in PSia, 144 is the conversion from ft² to in², 60 is conversion from minutes to hours, 48.24 is the O₂ gas constant in the $\frac{\text{lb}_f \text{ ft}}{\text{lb}_m \text{ } ^\circ\text{R}}$, and 510 is gas

temperature in ^oR.

5.3.2.6 Calculate the sensible heat picked up by the oxygen stream through the suit. (IQSE)

$$\text{IQSE} + \text{IFLS} * (\text{ITGO} - \text{ITGI}) * .3$$

5.3.2.7 Calculate the total latent load that must be removed from the body to maintain comfort at the input IDTT. (IX)

$$\text{IX} = (\text{IQLC} / 0.859) = 180 - \text{IQSE} - \text{ISUN} - \text{IQLC}$$

where,

$\text{IQLC} / 0.859 + 180$ is approximately equal to the total metabolic rate at comfort.

5.3.2.8 a. Calculate the metabolic rate at IDTT comfort (IQMT).

$$\text{IQMT} = \text{IQLC} + \text{IQSE} + \text{IX} + \text{ISUN}$$

b. Obtain the lung latent heat rate (IQLL) from curve 3 based on IQMT.

$$\text{IQLL} = \text{A3} * \text{IQMT} + \text{IB3}$$

where,

A3 = slope (see curve 3) = presently set to +0.1013

IB3 = intercept (see curve 3) = presently set to 0.

5.3.2.9 Similarly obtain the skin diffusion (IQDF) from curve 4 based on IQMT.

a. If IQMT -2000. is less than or equal to zero compute

$$IQDF = A4 * IQMT + IB4$$

A4 = presently set to -0.038

IB4 = presently set to +75.

b. If IQMT -2000 is greater than zero, set IQDF =17.

5.3.2.10 Calculate the sweat rate IQSR at IDTT comfort from the total latent load (IX), lung latent (IQLL) and the skin diffusion (IQDF).

$$IQSR = IX - IQDF - IQLL$$

5.3.2.11 a. If IQMT - IMR1 is less than or equal to zero, set
ISTD = 1.

b. If IQMT - IMR1 is greater than zero, compute ISTD as follows:

$$ISTD = (IMR1 + (IQMT - IMR1) * (ITWI 8 0.0235 + 0.590)$$

$$-IQDF - IQLL - IQSE - IQLC - ISUN) / IQSR$$

5.3.2.12 If sweat factor (IFAC) is equal to zero, compute sweat rate at inlet coolant temp at comfort by:

$$(a) IQST = IQSR$$

(b) If sweat factor is equal to a one, compute

$$IQST = IQSR * ISTD * IFAC$$

5.3.2.13 Compute the total latent load at ITWI comfort (IQWV)

$$IQWV = IQST + IQDF + IQLL$$

5.3.2.14 Finally, compute the total metabolic rate adjusted (ISLC).

$$ISLC = IQWV + IQSE + IQLC + ISUN$$

5.3.2.15 The delta energy for the LCG is computed and displayed every consecutive 15 second as follows:

$$\Delta E = \frac{\sum_{i=1}^{15} ISLC_i}{15}$$

displayed every

15 seconds as ΔE XXXX H

5.3.2.16 The average minute energy is computed and displayed for LCG as follows:

$$\text{Average LCG energy} = \frac{\sum_{i=1}^N \text{LCG}_i \text{ energys}}{4}$$

displayed every minute under Δ for LCG as follows:

XXXX ■ H

5.3.2.17 The total energy expended (TTLC) in BTU's (displayed as XXXX ■ on bottom right hand corner of display) is computed as follows:

$$\text{TTLC} = \sum_{i=1}^N \text{TTLC}_i + \text{TTLC}_N / 60$$

where,

$i = 1, N$

N = total number of one minute energys

60 = conversion factor for BTU's.

See attached example of system B displays.

1

EMU	TRA	IN	ING	CHAM	B	JAMES	A	LOVELL
L O C A L	6 9	0 9 4	2 3 : 5 9 : 5 3					
M I N	H R = 0 0 8 8							
L O C A L								
M I N								
A V G	1 5 0 0							
1 8 : 2 2 : 0 9	I N T	0 3 0 0						
1 8 : 5 9 : 4 3	I N T	0 4 0 0						
1 9 : 2 6 : 1 7	I N T	0 5 0 0						
1 9 : 3 1 : 2 2	I N T	0 1 0 0						
2 0 : 3 1 : 2 6	I N T	0 3 0 0						
2 0 : 5 9 : 2 9	I N T	0 0 5 0						
2 1 : 4 6 : 3 9	I N T	0 1 0 0						
2 1 : 5 7 : 5 7	I N T	0 2 0 0						
2 2 : 3 4 : 5 1	I N T	0 1 0 0						
2 2 : 3 6 : 4 4	I N T	0 6 0 0						
2 2 : 4 9 : 5 1	I N T	0 3 0 0						
2 3 : 0 1 : 5 7	I N T	0 3 3 3						
2 3 : 1 6 : 1 9	I N T	0 1 9 5						
2 3 : 2 4 : 4 6	I N T	0 2 5 0						
2 3 : 2 9 : 4 6	I N T	0 9 0 0						
2 3 : 4 0 : 1 1	I N T	0 9 9 9						
2 3 : 5 7 : 3 3	I N T	0 8 0 0						
T O T	3 0 0 0							

EMU TRAINING CHAM X * * TEST SUB NAME *
COMPUTATION CONSTANTS CURR ENTLY IN USE
SLOPE * + 21.45 * INTERCEPT * - 1000 * SLR * 060 *